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LITERATURE REVIEW ON COMPETITION VERSUS SOLE SOURCE PROCUREMENTS

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After a review of the literature on the topic of competition versus sole source procurements, several points emerge. First, there is probably some rationale for supporting competitive over sole source procurements, but it should be recognized that not all competitive procurements produce savings; and the savings associated with going competitive are probably far less than the old 25 percent savings number used by Defense Secretary McNamara. Next, there are several factors that should be considered prior to a decision to go competitive, such as production quantity, complexity of the item, capacity utilization of the industry involved, special skills, and sufficient data on the item. In addition, a cost benefit analysis should probably be performed to determine the possible savings as a result of competition. Further, low dollar value spare parts, required in considerable quantity, or component parts/systems that are jointly used extensively by private industry, would seem to be the best places to implement competitive procurements.

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Executive Summary

After reviewing the literature on the topic of competition versus sole source procurements, several points come to mind. First, there is probably some rationale for supporting competitive over sole source procurements, but it should be recognized that not all competitive procurements produce savings; and the savings associated with going competitive are probably far less than the old 25 percent savings number used by Secretary McNamara. Next, there are several factors that should be considered prior to a decision to go competitive, such as production quantity, complexity of the item, capacity utilization of the industry involved, special skills, and sufficient data on the item. In addition, a cost benefit analysis should probably be performed to determine the possible savings as a result of competition. Further, low dollar value spare parts, required in considerable quantity, or component parts/systems that are jointly used extensively by private industry, would seem to be the best places to implement competitive procurements.

Older Studies on the Benefits of Competition

There were several early studies that dealt with comparing sole source to competitive procurements. These were generally based upon small limited sample sizes, and dealt with preliminary small systems or electronic components. The studies generally found consistent cost savings associated with competition programs, but in most instances failed to take into account all the costs associated with the competition process, such as the cost of conducting the competition, set-up costs for the new contractor, special tooling and Government furnished equipment, and the time value of money to set up the new contractor:

Carter (1974) proposed that the Air Force try "directed licensing," where the original contractor, during development phase, agrees to provide rights in the data, and to an agreement to license to whomever the Government designates to produce the weapon system during any or all production runs following initial production. This procedure Carter felt would save money by forcing competition. He stated that previous contracting studies showed a 25 percent reduction in cost due to competition.

Olson, Cunningham and Wilkins (1974) found the range of cost savings associated with competition of spare parts to range from 10 to 17 percent, with the most likely savings being 12 percent. They were cognizant of competition costs, but felt that for spare parts competitions, they generally would be negligible.

Zusman and Asher (1974) in this large study found that competition reduced costs by an average of 37 percent. However, as mentioned previously, they did not take into account the costs of conducting the competitions or their associated costs.

Lovett and Norton (1978) compared the price behavior on 11 competitive contracts that had previously been sole source. They found cost savings from 0 to 34 percent, however, as above, they did not take into account the costs associated with the competition.

Daly, Gates and Schuttinga (1979) examined 31 programs and showed an average price reduction of 35 percent for competition on five missiles, a bomb, a guidance unit and assorted electronic components. They stated that savings for a "split award" would be about a 10 percent reduction, and a 20 percent reduction for winner-take-all competitions. This study also failed to take into account the cost of conducting the competition.

Drinnon and Hiller (1979) expanded upon the work of Lovett and Norton (1978), reviewing 45 programs; they also found savings reductions ranging from minus 16 percent to 67.7 percent, with the median around 39 percent. Like the previous studies, most of the items were subassemblies and small electronic components. Major systems in their study only achieved from 10-18 percent reductions (i.e., FAAR, TOW and Shillelagh). They likewise did not take the cost of the competition into account.

Kratz and Cox (1982) expanded upon the conceptual framework of Drinnon and Hiller (1979), and suggested that what transpired with the creation of competition was a shift

and rotation of the learning curve, with an immediate drop in the first unit cost and a steeper learning curve. In applying their approach to five missile procurements, they found that the first unit cost was reduced by between 14 percent (4 percent shift and 8 percent rotation) to 46 percent (14 percent shift and 13 percent rotation). The model outlined in this approach is available from Defense Systems Management College under the name of the Competition Evaluation Model (CEM), version 2.0 (1992). Beltramo (1989), however, took exception with the logic behind this model, and in a study performed for the Naval Center for Cost Analysis found only one example of this type of shift and rotation, out of six cases. In the remaining cases, he found a downward initial shift with an upward rotation (i.e., a lower price for the first competitive lot, followed by a flatter learning curve than expected for the sole source).

As one looks at these early studies, it is hard to determine how beneficial competition is to the procurement process, though it does seem obvious that there is a general cost savings associated with competition, especially on spare parts. In an attempt to compare the studies results for consistency, the same procurements were reviewed across different studies (see Table 1).

TABLE 1. Variance Among Studies on Cost Savings

STUDIES	ZUSMAN	LOVETT	DALY	DRINNON	KRATZ	GREER	
SYSTEMS							*Range*
TOW	48	9	9	12	20	26	40
SHILLELAGH	0	6	-8	9	-	-5	17
BULLPUP	14	-	32	27	46	18	32
SIDEWINDER 9D/G	-	-	-5	1	-	-71	72
SIDEWINDER 9B	-	-	1	-6	17	-	23
SPARROW 7F	-	-	-	-	14	-25	39

In looking at these systems, there was considerable variability in results from one study to the next, of what should have been fairly similar results. For instance, some procurements went from a cost savings to a loss. Most striking was the Sidewinder 9D/G and the Sparrow 7F competitions, which displayed significantly different results between the studies, while the other common systems showed considerable variation from one study to the next. This variability in results can be attributed to the use of different definitions as to what was to be considered in the

study, and, as a result, different costs were applied from one study to the next. A good example of how this can happen is presented by Hampton (1984), where he demonstrates on one system, the Shillelagh, how savings can very from minus14 percent to 22 percent depending upon the use of different data, different statistical methods, or different definitions of what savings constitute. Thus, from the foregoing studies, it is hard to place a firm number on what the actual savings associated with competition might be.

Second Phase of Studies on the Benefits of Competition

Either as a result of the previous studies, or perhaps relating to increasing public interest in reducing defense costs, the DoD Cost Analysis Symposium of 1982 generated four papers on the topic of competition. These papers attempted to provide a more comprehensive approach to the question of savings due to competition; and also started a slightly different approach to research in this area, in that they discussed several constraints that should be considered prior to the decision of whether a system should be competed.

Trainor (1982) brought out in his review of Lovett and Norton (1978) and Daly, Gates and Schuttinga (1979) that the majority of items (48/55) compared in these studies were non-major systems, and only had unit costs of between $4,100 to $8,400 (FY80 dollars). The only major weapon systems in these studies were one ship, one medium size missile and one small helicopter. As such, he suggested that their results, concerning the benefits of competition, should only be applied to non-major system procurements. In addition, Mr. Trainor discussed several reasons why competition may not either be practical, or produce cost savings in the future, especially if current trends for defense contractors continue. These points are rather interesting, and in light of our current defense draw-down, will be discussed later in the paper.

Watkins (1982) followed up on the Kratz and Cox (1982) model for estimating the slope for competitive contracts. He discussed the historical data by commodity area (e.g., electronics, missiles, etc.) and what the rotation and shifts could be for them based upon previous contracts. He also proposed the use of Should Costs, using the model to determine the learning curve that the contractor should agree to for production.

Smith and Lowe (1982), like Watkins (1982), looked at the Kratz and Cox (1982) model for estimating the slope differences between competitive and sole source procurements. Their results supported the shift and rotation premise and suggested that between a 15 and 25 percent savings on spare parts could be achieved by competition. They did not mention whether the cost of the competition was taken into account.

Carrick (1982) discussed experience curves and the factors that influence them. Like Trainor (1982), he also mentioned that there were several problems that contractors have in their estimation process for competitive bids, which may cause cost growth over their initial estimate. For instance, in the DIVAD program the winning contractor had not even generated designs for several of the equipments, yet submitted a cost estimate for them. Also, in the Viper and Copperhead programs, neither of the winning contractors

adequately understood the technology underlying their designs, much less the exceptional difficulties in defining and implementing a high rate of production technology. These examples point out that one cannot just use the bid price from the contract as data for competition studies, rather the actual production costs should be used.

More Comprehensive Studies on Competition

Following this time period, the research on sole source versus competition changed from somewhat simple comparisons to multiple factor analyses. These studies recognized that there were several possible factors that could come into play in affecting the costs associated with contracting. A number of these studies were masters' theses from the Air Force Institute of Technology, and were very well done analyses:

Brost (1982) conducted a regression approach to determine the savings associated with competition, comparing the estimated sole source cost on spare parts procurements to the actual competition prices, controlling for inflation and commodity type. His results ran counter to the earlier spare parts studies, and indicated a general negative trend as a result of competition. These results could have been influenced by the small number of procurements that met his criteria for inclusion into the study (36). Further, while recognizing that there were additional costs associated with competition, the study did not add these costs to the competition side of the equation, thus the results of this analysis would be even less favorable toward competition than what he had portrayed.

Zamparelli (1983) followed up on this spares analysis, and, in turn, found some savings associated with competition (4.1 to 11.2 percent), however there were several times that competition was not found to be beneficial. For instance, on aircraft engine parts, where there were relatively few companies that could supply a particular engine's spare parts, even if proprietary data were not involved, competition was not effective in reducing costs, since the second source of supply may need to retool and change their machine specifications in order to produce the parts. Another instance was where the spare parts exceeded $1,000 in unit costs, competition did not save money. Lastly, there were some instances where competition increased costs by two to eight times the sole source cost, however, these instances may stem from the part not being manufactured any longer. The study, like the previous studies, did not consider the cost of competition in its analysis.

Greer and Liao (1983) investigated contractor profitability and capacity utilization in relation to competition cost savings. Using three of the six missile competitions from Kratz and Cox (1982), they concluded that competition produces greater savings when firms are at low capacity, however, when capacity utilization was high, there was little benefit attributed to competition. The worst cases occurred when capacity utilization was above 80 percent. In those instances, there were net losses associated with competition.

Heinz (1983) looked at a factorial approach to sole source vs. competition. He suggested that for the early development of armament systems sole sourcing was best, but, as the systems matured to the 6.5 level, competition became more favorable. His suggestions

seemed to principally be related to the complexity of the system, in that the more complex the process, the more appropriate sole source became.

Hampton (1984) generated an excellent paper on sole source versus competition, looking at the previous studies mentioned above, critiquing them upon their methodology and suggesting a more appropriate approach to determine if competition was worthwhile. Generally, he came to the conclusion that competition was not always cost effective or practical, and that in order to determine if there were any advantages to a system going competitive, a cost benefit analysis should be performed that would take into account all the costs associated with the Government and the contractors, and would use discounted dollars in accordance with OMB Circular A-94. His paper was basically broken into three sections. The first, a complete discussion of previous research, then, the factors that should be considered in determining if competition were cost effective, and, third, a discussion of a cost benefit approach that could be applied to determine the reasonableness of competition. He also discussed, in the second section, several studies that took these additional Government and contractor costs into account, and found that competition was not cost effective for those systems.

Gable (1985) looked at whether competition reduced spare parts procurement costs. The study did indicate a savings associated with competition, but he discussed that competition is not always possible due to several factors (e.g., inadequate/missing data, proprietary rights, shrinking industrial base, etc.). He recognized also that there were several costs associated with competition that might outweigh the benefits in gross savings (competition personnel costs, contracting personnel costs, increased processing time required to conduct the competition, and the additional paper work required).

Presar (1986) discussed how the pressure to increase competition would cause increasing workload requirements on the commodity commands, in terms of personnel and time to conduct these procurements. These manpower requirements would be borne by the commodity commands and not funded by the weapon systems, nor out of the normal command's budget; thus causing the offices in those commands to absorb the increased man-hours out of their existing work force.

Berg, Dennis and Jondrow (1986) performed a literature review of the previous studies on sole source versus competition. They recognized the inconsistencies of the previous studies and attempted to outline why differences may have occurred (e.g., use of differing data, different adjustments, different assumptions, etc.). Their recognition of these possible problem areas and their subsequent effect upon the previous studies was quite good. They also suggested that the Price Improvement Curve model of Kratz and Cox (1982) may not take enough variables into consideration for true forecasting purposes.

Gansler (1989) discussed several points in his book on "Affording Defense." First, he discussed how in the fair-and-open environment that Congress has created that it can lead to too many bidders entering the competition than is good for either the Government or for the contractors themselves (pointing out a case where DoD spent time and money

evaluating fifty bids for a few-hundred-dollar item). These situations hardly make sense, and can promote inexperienced, weak manufacturers, when DoD with its substantial buying power should be obtaining the most effective weapons for the lowest cost. He also stressed the importance of continuous competition, where, if possible, not only the initial procurement is competed but also the production contracts; preferably with a leader-follower award, so that there continues to be a competitive pressure on the manufacturers. He stressed however that competition should make sense, and that, in an environment that stresses competition and low cost, there are dangers concerning the quality of DoD items if it is carried too far. He sums up these concepts with the following statement: "Competition for its own sake is clearly wrong; however, when competition makes good management sense and when best value is emphasized, that is a different story."

Kitfield (1989) discussed whether some programs that were being represented as competitive were really competitive. He also referred to a Navy study of eight separate weapon systems that estimated the cost of bringing on a second source at between 2 to 4 percent of the total cost of the procurement.

Boger, Greer and Liao (1990) discussed that competition in weapon systems does not always produce savings. They reemphasize Greer and Liao's (1983) previous study, where capacity utilization above 80 percent produced losses when systems were competed. They also discussed several factors that could come into play to make competition not as effective as in private industry, due to the Government being the sole buyer, with only limited production and few companies capable of producing the items, which requires the Government to help establish the second source.

Flynn and Herrin (1990) indicated that the Navy has been having success with competitive procurements on large weapon systems, achieving a 14 percent savings (these savings however did not take all competition costs into account). They estimated that the startup costs for the second source represented 2.4 percent of the total program costs. However, they tempered their 14 percent savings estimate by saying that these previous procurements were during the 1980's defense buildup time, and may not hold in the current defense drawdown period with reduced quantities.

Carlson, Hamre and McNicol (1990) discussed several issues concerning weapon system competitions at the DoD Cost Analysis Symposium (1989). This was the second time that a majority of papers at the symposium has dealt with competition (1982). In their discussion they covered several areas of possible concern for future competition efforts, such as the complexity of the system and whether complexity in and of itself would preclude dual sourcing. They also discussed that dual sourcing may be driving companies to share less information with one another, out of fear that they may end up competing with each other at a later date, and that this impaired the technical capability associated with new defense technologies. They also discussed that the current preoccupation with price is not in keeping with the new trends in total quality management, and that best value should be the principal goal for defense procurements.

Elliot (1990) looked at the impact of competition on the quality of the items procured. The study found no significant difference in quality as a result of changing from a sole source producer to a subsequent competitive winner. However, these procurements were for spare parts and may not be representative of major systems or components under development.

Wandland and Wickman (1993), like previous studies, found that competition showed reduced costs over sole source procurements, though the difference was not statistically significant. The study also examined the question of whether contractors might be buying in on competitive contracts. In this regard, they found that counter to what might be expected, competitive contracts had less cost and schedule growth than sole source contracts, though the differences were not statistically significant. Like previous studies, the costs associated with competition were not considered in their results, though they were aware of several competition costs (i.e., technology transfer to second source, additional Government management, time value of money, purchasing reprocurement data, special tooling and test equipment).

Discussion

Given the variability of results from the preceding studies, and the subsequent recognition that several factors are involved in the ultimate determination of whether competition is cost effective, it seems prudent to take a conservative approach to the question of when competition should be used. Like several of the other investigators in this area, I have come to the conclusion that competition "savings" are dependent upon several factors, ranging from industrial base issues to how costs are defined in the analysis. Trainor (1982) and Gable (1985) discussed several of the industrial base issues that could influence production costs, and should be considered in the decision process of whether to use sole source or competition in meeting the procurement need for an item.

◊ Production rate - in single line production (where only one type of item can be produced on the production line), higher production rates allow more efficient production, and so, lower costs. This factor was coming into play in 1982, with decreasing production rates, and has continued to be a factor as weapon systems have become more complex, and require higher sophistication than standard manufacturing products.

◊ Stable production rate - in single line production, a stable production rate allows for more efficient production, and so, lower costs. Stable production rates were becoming a problem for military manufactures in 1982, and have continued to be a factor as funding for military programs has undergone continuing readjustments, which in turn causes production slippages.

◊ Production quantity (a combination of the previous two factors) - in single line production, large quantities allowed more efficient production, and so, lower costs. This factor had been decreasing for 10 years prior to 1982, and continues to decrease in the present environment.

◊ Time required to stabilize design - unless the design is firm, there is the possibility of cost growth. The increased complexity and testing requirements of weapon systems back in 1982 prompted this concern, which has continued to increase with the current sophistication and complexity of state-of-the-art systems. Some examples from Carrick's (1982) study were the DIVAD program, where the winning contractor had not even designed several of the components, when they submitted their bid. Also, in the Viper and Copperhead programs, neither of the winning contractors adequately understood the technology, nor the high rate production techniques required when they made their bids on these systems.

◊ Capacity utilization (both in terms of workers and facilities) - as a company's plant utilization increases, the associated costs for their product decreases as a result of no longer carrying as much overhead/excess capacity. This point was also recognized by Greer and Liao (1983) and Boyer, Greer and Liao (1990) in their studies, in that when capacity utilization exceeded 80 percent, competition started to produce negative results, perhaps because companies' efficiencies were operating at about the same level, so costs between companies would be similar. As defense contractors continue to merge, most are now operating at or near full capacity, and cannot achieve significant savings by reducing excess overhead.

◊ Special production skills and facilities - it is easier to establish a second production source if the need for specialized skills and facilities does not exist. However, with weapon systems becoming increasingly unique, only limited facilities are available to produce some systems (i.e., tanks, submarines, aircraft carriers, etc.), so that possible competition for an increasing number of weapon systems is reduced. These problems were also discussed by Zamparelli (1983), where he found that on aircraft engine parts, there were relatively few companies that could supply the components.

◊ Production drawings - it is difficult to establish a second production source if drawings are not available. As funding has become tighter over the years, several programs have opted for reducing the number of system drawings for their components, or not updating those drawings as design modifications have changed the components.

◊ Proprietary data rights - it is difficult to establish a second source if the system or component uses proprietary information. Many contractors incorporate components and parts in their systems, for which they hold the proprietary rights.

In addition, there are several costs associated with competition that should be taken into account to determine if competition will really save money. Hampton (1984) and Beltramo (1990), discussed several of these in detail in their papers:

◊ The source selection costs, which includes both the Government personnel and facilities required, along with the contractor's cost to develop the proposal.

◊ Second source development costs, such as updating the technical data package, special tooling and test equipment required, cost of transferring the technical data to the new source, and first article testing.

◊ Other possible liabilities to the Government, concerning the undepreciated assets that the Government my have to pay for, or furnish to the new source.

◊ Quantity and learning curve losses in production, if quantities are split between several sources.

◊ Increased contract administration costs, if quantities are split between several sources.

◊ Increased technical data administration cost for updating more than one source.

◊ Company funded R&D costs that need to be recaptured by the original developer.

Added to these costs would be the logistics costs associated with maintaining multiple versions of a system in the inventory, and its required spare parts that are unique to its respective version. These costs have not been discussed in the literature. Tied into this would be the increased training required for repair of the different versions, and their respective technical manuals.

In order to completely cover the topic, the leading professors and experts in the field were contacted for their opinions and expertise: Beltramo (1996), Fullerton (1995), McAfee (1995), Rao (1995), Rogerson (1995), Vincent (1995), Wilson (1995) and Yao (1995). These discussions led to some additional studies and books, not found on the initial literature searches.

Anton and Yao (1987, 1989, 1990 and 1992) have done several theoretical papers on the effects of full costing knowledge vs. incomplete information on the bidding process. They point out the following conclusions:

◊ The developer's production experience provides a cost advantage over a second source bidder, however, this pricing advantage can be offset if competition is not conducted until later in the program, and the initial cost information is provided to all bidders.

◊ In an environment with unequal cost information, both the bidder and the buyer benefit from a split award over a winner-take-all award; while in an open cost knowledge environment, the buyer receives a lower cost under a winner-take-all process.

Recently, Fullerton (1995a and 1995b), Fullerton and McAfee (1996), and Taylor (1995) have expressed some novel and interesting proposals concerning competition. These are termed "Research Tournaments," in which the competition procedure is structured as an auction and prototype competition, with the winner awarded a "prize" for the best product. The auction component consists of the participants paying a fee for

entering the tournament, which could be pooled across the participants to defray the cost of the prize, or offset the cost of conducting the competition. This prize could either be a set amount of money based upon what the Government determined the work effort to be worth, or if the contract award was large enough, or had commercial applications, the award could constitute just the winning of the contract, since the follow-on work would generate sufficient commercial incentive.

Dr. Vincent suggested an article he had written on optimal procurement mechanisms (Manelli and Vincent (1995)); this was similar to the work of Drs. Anton and Yao above (1987, 1989, 1990 and 1992) and looked at theoretical competitions. He proposed that the optimal competition environment would be to first offer to a select group of companies, in a sequential process, a fixed price to perform the work, and if they all should reject the price, then hold an auction.

Summary and Conclusions

After reviewing the literature on the topic of competition versus sole source procurements the following points come to mind. First, that there is probably some rationale for supporting competitive over sole source procurements, but it should be recognized that not all competitive procurements produce savings; and the saving associated with going competitive are probably far less than the old 25 percent savings number used by Secretary McNamara. Next, that there are several factors that should be considered before a competitive procurement should be selected; such as production quantity, complexity of the item, capacity utilization of the industry involved, special skills, and sufficient data on the item. In addition, a cost benefit analysis should probably be performed prior to determining to go competitive, to determine if there might be any savings as a result of competition. Lastly, the best situation for competition would seem to be in the area of low dollar value spare parts required in considerable quantity, or in component parts/systems that are jointly and extensively used by private industry.

Currently, competition is the prescribed means of procurement, but we should be aware of the ramifications that this policy creates both for private industry and the military. For private industry, this may have led to their current hypersensitivity concerning their research and manufacturing technologies; as evidenced by their great concern about sharing information with other contractors, for fear that they may be competing with them in the future. Carlson (Carlson, Hamre and McNicol (1990)) discussed this concept with Hamre and McNicol at the 1989 Department of Defense Cost Analysis Symposium, and pointed out that in the past, where specific companies had "baronies" for a particular area, they maintained top notch engineers for long periods of time at one location. These groups of experts formed a type of synergy for research in that area, which in turn led to the development of new technologies and a willingness to share technical information with other industries. Carlson's statement that this situation no longer exists has recently been echoed by industry representatives as a "kill or be killed mentality" in the current environment (National Defense (1996)). Rather, companies hide what they are doing, and do not allow their employees to discuss their work at symposiums like the American Defense Preparedness Association, or the National Industrial Security Association meetings. This, in turn, he stressed, places a handicap upon new technologies developing in

these defense industries, and drives the services to depend more on commercial developments to generate the high technology equipments required in order to maintain a technological edge over other countries. Mr. Hamre, in these same discussions, brought out the current overemphasis on cost cutting, which he pointed out runs against the grain on what we now consider to be the correct business behavior of total quality management, where price is not the primary issue. This point of view has caused a change in recent years to "best value" competitions, where quality and value are considered in relation to price.

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